Yoshiharu KUWABARA*: **The first seedling leaf in grass systematics**

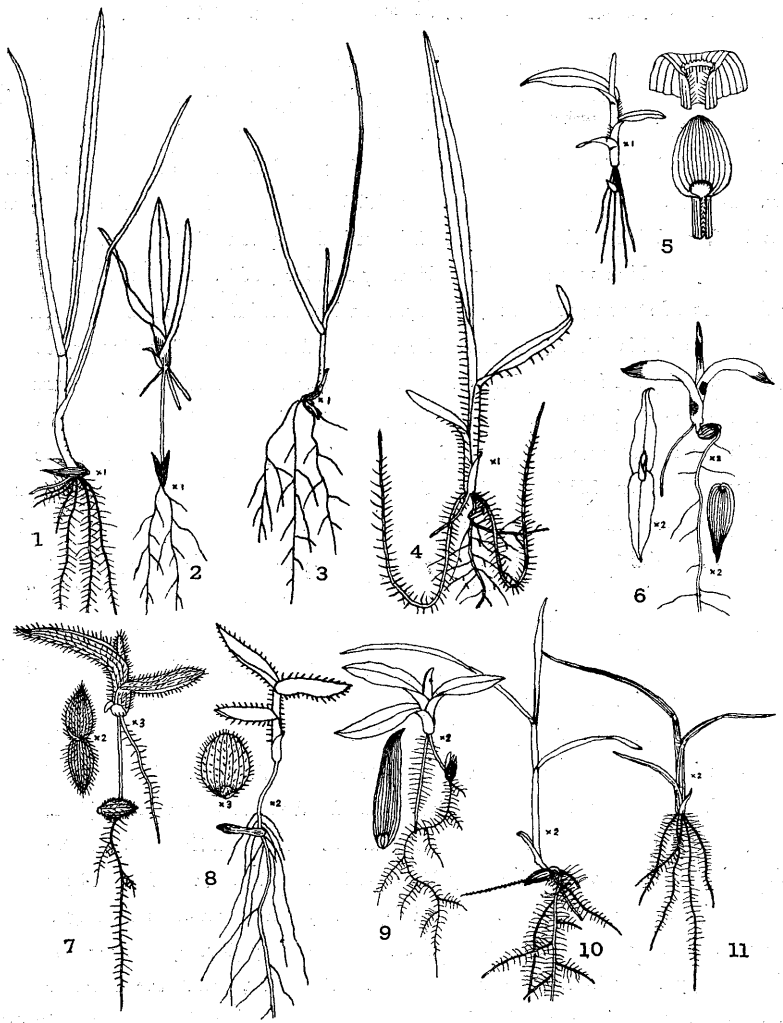
桑原義晴*: イネ科における幼苗第一葉と系統分類

In 1931 a noteworthy paper regarding the grass systematics was published by a Russian botanist, Avdulov. He not only introduced chromosome features into the systematic investigations of grasses, but also discussed the features of leaf anatomy, starch grains of seeds and the first seedling leaf from the systematic point of view. Earlier, Grob (1896), Duval-Jouve (1875) and others studied the structure of grass leaf, and Van Tieghem (1897) initiated the systematic-anatomical study of grass embryo, which was recently verified by Reeder (1953). Hayek (1925) discussed the features of starch grains in grass systematics. Avdulov (l. c.) cited these previous studies in his discussion when he developed the basis of modern systematics of grasses, although he completely neglected the characters of embryo structure.

There are various characters which were found to be significant in grass systematics by recent workers, and of these the embryo structure seems the most important. Reeder (1957) examined the embryo of some 300 species representing over 150 genera and all tribes usually recognized. Brown (1958) reexamined the leaf anatomy of grasses and recognized siz types. He and his collaborators contributed findings of new systematic criteria: the persistent nucleoli (Brown and Emery 1957), the organization of the shoot apex (Brown, Heimsch and Emery 1957), and the germination responses to iso-propyl-phenyl carbonate (Al-Aish and Brown 1958). The histological features of grass leaf epidermis were studied by Prat (1936), who arranged the members of the grass family in a new phylogenetic system. The leaf structure of various grass groups whose systematic position remains uncertain have been subjected to studies by recent workers (de Wet 1956, Potztal 1952, Metcalfe 1956, Jacques-Felix 1955, Tateoka 1958, a. o.). New findings about the starch grains of grass seeds were added by Dore (1956) and Tateoka (1955). Chromosome features of grasses have been examined by many investigators including Avdulov (1931), and our present knowledge about them is greatly developed wnen compared with that appearing in Avdulov's discussion. The finding that the lodicule, pistil and caryopsis are of great value in grass systematics is very interesting. Hubbard (1946), Church (1949) and Stebbins (1956a) disclosed the fact that when several

* Kucchian High School, Hokkaido.

controversial grass genera are classified according to these morphological features the results are in accordance with those obtained by non-morphological characters. This finding is particularly interesting as it shows that the phylogenetic relation-




Figs. 1–11. Seedlings of grasses. 1, *Bromus catharticus*. 2, *Dactylis glomerata*. 3, *Festuca elatior*. 4, *Paspalum thunbergii*. 5, *Panicum bisulcatum*. 6, *Setaria viridis* var. *purpurascens*. 7. *Digitaria adscendens*. 8, *Arthraxon hispidus*. 9, *Eleusine indica*. 10, *Muhlenbergia japonica*. 11, *Eragrostis multicaulis*.

ships are reflected in morphology.

As mentioned above, most of the characters which were introduced or discussed systematically by Avdulov (l. c.) have been subjected to further studies which yielded interesting results. However, this is not the case with the first seedling leaf. Although Stebbins (1956 b) cited it as a useful character for grass systematics and several authors reported its features in discussing the systematic relations of some particular grasses (de Wet 1959, Tateoka 1956, a. o.), no noteworthy paper regarding the first leaf has been published after Avdulov (l. c.).

According to Avdulov, the first seedling leaf of grasses can be divided into two distinct types: Type I (panicoid), first leaf oval, oblong or lanceolate and horizontal of ascendant; Type II (festucoid), first leaf linear and perpendicular. The former type characterized the members of his subfamily Sasccharifierae and the latter is shared by the members of his subfamily Poatae. Avdulov reached this conclusion from his own observations.

I am examining the seedlings of herbaceous plants from the taxonomic point of view. Up to now the seedlings of 33 grass species were observed. Based on the results obtained by my examinations the systematic significance of the first leaf will be considered here. Table 1 shows the summary of my observations, whose details were already published in Japanese (Kuwabara 1956: 1955–58).

It is desirable to clear up the difference between "linear" on one hand and "oblong" or "oval" on the other, so I calculated the ratio of length to width of the leaf: the larger the ratio, the narrower the leaf. Its length and width vary according to an individual, and the median of the measurements is adopted for calculation.

Eighteen species were observed in Festucoideae (Table 1). Their first leaves are without exception perpendicular and mostly linear. The ratios of length to width vary between 10.3 (*Dactlis glomerata*) and 106 (*Festuca elatior*), but the large majority (13 spp.) fall into 15–30. In Panicoideae, 9 species (and 2 varieties) were examined. Their first leaves are horizontal or ascendant, and the shapes of the leaf are various (cf. Table 1), the linear leaf being shared by *Paspalum thunbergii*. The ratios of length to width vary from 1.3 (*Arthraxon hispidus*) to 12 (*Paspalum thunbergii*). But, except for the latter species, none has a larger ratio than 6.6. The four species of Eragrostoideae, whose members were included in Saccharifierae together with Panicoideae by Avdulov, are rather diverse in the features of the first leaf. *Zoysia japonica* has a ratio of 15.5, and the first leaf is

linear and perpendicular. The leaves of *Muhlenbergia japonica* and *Eragrostis multicaulis* are ascendant, and show the ratio of 10, whereas *Eleusine indica* has a typical panicoid leaf. The first leaf of *Leersia oryzoides* is perpendicular and linear, the ratio being 25.9. Tateoka (1956) reported the features of the first seedling leaf of *Phyllorachis sagittata* Trim. whose relation with Oryzeae is deduced by Hubbard (1939), de Wet and Anderson (1956) and Tateoka (1956). The leaf of this

Table 1. The features of the first seedling leaf.

| Species | shape | length (mm) | width (mm) | length / width | occurrence |
|---|---|---|---|---|---|
| Oryzoideae | | | | | |
| Oryzeae | | | | | |
| *Leersia oryzoides* Sw. | linear | 35 | 1.2–1.5 | 25.9 | perpendicular |
| Arundoideae | | | | | |
| Meliceae | | | | | |
| *Melica nutans* Linn. | linear | 25–30 | 1.2 | 22.9 | perpendicular |
| Festucoideae | | | | | |
| Festuceae | | | | | |
| *Brachypodium sylvaticum* P. Beauv. | linear | 30–35 | 2–2.5 | 14.4 | perpendicular |
| *Bromus catharticus* Vahl. | linear | 25–26 | 1 | 25.5 | perpendicular |
| *Dactylis glomerata* Linn. | linear-lanceolate | 15–16 | 1–2 | 10.3 | perpendicular |
| *Festuca parvigluma* Steud. | linear | 20–25 | 1 | 22.5 | perpendicular |
| *F. elatior* Linn. | linear | 40–45 | 0.3–0.5 | 106 | perpendicular |
| *Poa annua* Linn. | linear | 10–15 | 0.5–0.7 | 21 | perpendicular |
| *P. sphondylodes* Trin. | linear | 8–18 | 0.6–0.8 | 18.6 | perpendicular |
| *P. pratensis* Linn. | linear | 15–25 | 0.5–0.8 | 31 | perpendicular |
| Agrosteae | | | | | |
| *Avena fatua* Linn. | linear-oblong | 35–40 | 3–3.5 | 11.5 | perpendicular |
| *Beckmannia syzigachne* Fern. | linear | 10–35 | 0.5–0.8 | 26.9 | perpendicular |
| *Anthoxanthum odoratum* Linn. | linear | 25–30 | 1 | 27.5 | perpendicular |
| *Milium effusum* Linn. | linear-oblong | 15–40 | 1.5–1.8 | 16.7 | perpendicular |
| *Phleum pratense* Linn. | linear | 15–30 | 0.8–1 | 21 | perpendicular |
| *Alopecurus aequalis* Sobol. var. *amurensis* Ohwi | linear | 6–15 | 0.4–0.6 | 21 | perpendicular |

| | | | | | |
|---|---|---|---|---|---|
| *Agrostis clavata* Trin. var. *nukabo* Ohwi | linear | 7–15 | 0.3–0.6 | 24.4 | perpendicular |
| *A. palustris* Huds. | linear | 10–15 | 0.5–0.8 | 19.2 | perpendicular |
| Triticeae | | | | | |
| *Agropyron ciliare* Franch. | linear | 35–45 | 1–1.2 | 36.4 | perpendicular |
| *A. repens* P. Beauv. | linear | 30–50 | 1–2 | 26.7 | perpendicular |
| Eragrostoideae | | | | | |
| Eragrosteae | | | | | |
| *Muhlenbergia japonica* Steud. | oblanceolate | 10 | 1 | 10 | ascendant |
| *Eleusine indica* Gaertn. | oblong, oblong-lanceolate | 5–8 | 1.5–2 | 3.7 | horizontal |
| *Eragrostis multicaulis* Steud. | linear | 3–10 | 0.6–0.7 | 10 | ascendant |
| Lappagineae | | | | | |
| *Zoysia japonica* Steud. | linear | 10–18 | 0.8–1 | 15.5 | perpendicular |
| Panicoideae | | | | | |
| Paniceae | | | | | |
| *Panicum bisulcatum* Thunb. | oval | 5.5–9.0 | 3–5 | 1.8 | horizontal |
| *Paspalum thunbergii* Kunth. | linear | 15–45 | 2–3 | 12 | ascendant |
| *Digitaria adscendens* Henr. | oval, oval-lanceolate | 3–5 | 2 | 2 | horizontal |
| *D. violascens* Link. | oval-lanceolate | 2.5–4 | 1.5 | 2.2 | harizontal |
| *Echinochloa crus-galli* P. Beauv. var. *praticola* Ohwi | linear-oblong | 10–18 | 2.5–3 | 5.1 | ascendant |
| *E. crus-galli* P. Beauv. var. *hispidula* Honda | linear-oblong | 8–25 | 2–3 | 6.6 | ascendant |
| *Setaria autumnalis* Ohwi | oblong-oblanceolate | 10–15 | 3.5–4 | 3.3 | ascendant |
| *S. viridis* P. Beauv. | oblong-oblanceolate | 8–9 | 2.3–2.8 | 3.3 | ascendant |
| *S. viridis* P. Beauv. var. *purpurascens* Maxim. | oblong, oblong-lanceolate | 8–10 | 2–2.5 | 4 | ascendant |
| *S. pumila* Roem et. Schul. | linear-oblong | 15–18 | 3–3.5 | 5.1 | ascendant |
| Andropoheneae | | | | | |
| *Arthraxon hispidus* Makino | round-oval | 3.5–4 | 3 | 1.3 | horizontal |

plant is somewhat different from that of *Leersia oryzoides*, as the former species has the leaf which is oblong-oval and ascendant. *Melica nutans* has a festucoid leaf standing perpendicularly, the shape being linear and the ratio 22.9.

As described above, the results obtained are mostly in accordance with Avdulov's (1931) conclusion that the distinction of the first leaf is quite parallel with the main systematic grouping. In several instances, however, there is contradicting evidence. The first leaf of *Paspalum thunbergii* and *Zoysia japonica* is not panicoid but festucoid. This finding does not destroy the systematic significance of the first leaf, but it clearly demonstrates that we cannot use this character "mechanically." It seems possible that the panicoid grasses have a series of variations from the typical panicoid to a festucoid first leaf, although the former is probably predominant. The same may be true in the Eragrostoideae. Considering the variation in the four species of this subfamily examined, this seems to be more possible.

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## 摘　　要

イネ科植物の幼苗第一葉の特徴は Avdulov (1931) によつて系統分類学的な形質としてとりあげられたが，その後，この形質に関してみるべき報告はない。筆者は 33 種のイネ科植物の幼苗を観察したので，その結果にもとずいて Avdulov の見解を検討した。

Avdulov はこの形質が分類学的な群別と非常によく一致すると強くいいきつているが，筆者の観察では必ずしもそのようにはならなかつた。ウシノケグサ亜科で調査した 18 種においては，Avdulov の記述と一致して，すべて所謂 festucoid の特徴をもつ幼苗が観察された。キビ亜科とスズメガヤ亜科では，多くのものは panicoid の幼苗であつたが，2 種（シバ及びスズメノヒエ）はむしろ festucoid とみるべき幼苗をもつていた。キビ亜科とスズメガヤ亜科において，幼苗の特徴に変異があり，大部分が panicoid のものであるが，それから festucoid の幼苗まで，移行型でつながれるのではないかと推定される。分類学的な考察の資料としてとりあげる場合，この形質も"機械的"な取扱いのできないことは明らかである。

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○ H. B. Gilliland: **Common Malayan Plants** (1598) B6判, 228頁, 222図。発行所 University of Malaya Press. $5 (マレー売価)

この書は現千葉大学教授渡辺清彦氏が陸軍司政官として馬来在住中に著作された，南方圏有用植物図説第1編薬用植物 (1944 年 8 月 20 日，馬来軍政監部発行，175 図収載) 及び第2編食用植物 (1945 年 5 月 20 日，昭南植物園発行，700 図収載) の両編中から撰たくしたものに新たに若干を追補して 222 図を収め，簡単な覚書説明と索引をつけて発売されたもので，渡辺氏の描かれた各図は氏の署名入りのままである。序文中には戦時中日本軍政部が科学者を任命して植物園を注意深く管理保存したことと，郡場，渡辺両教授が原図の使用を許諾されたことに対する謝意がのべてある。(久内清孝)